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Antiquity of some angiosperms in India based on palynological investigation

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Abstract

India moved northwards and negotiated a distance of 5,000 kms. approximately within 100 million years during Cretaceous and Tertiary periods. This had a drastic effect on the plants, some of the genera could not withstand the changing climate and perished; others migrated to new countries or perhaps gave rise to new ones. A few genera adapted to the new climatic condition and continued to flourish in the same soil. The antiquity of some of these genera based on palynological evidence is discussed here.

INTRODUCTION

India is situated between 8° – 36°N latitude offering a diversified climate comprising Thar desert with hardly any rainfall to Meghalaya having highest rainfall of the world, monotonous Indo-Gangetic plain to lofty Himalayas and tropical to temperate climate which resulted a diversified flora. The moist, rainfed tropical forests of India have different species of *Dipterocarpus, Hopea, Artocarpus* and *Mangifera.* The Western Ghat flora have the association of *Cullenia – Palaguium, Palaguium – Mesua, Mesua– Calophyllum, Vateria–Cullenia* etc. In the Himalayan temperate forests *Machilus edulis, Michelia cathcartii, Quercus* species, and different species of *Rhododendron, Abies, Pinus, Picea, Tsuga* and *Cedrus* thrive. In the Alpine forest *Abies, Juniperus, Betula* and some species of *Rhododendron* flourish. We have more than 4,000 species of angiosperms in North-East India alone. The question that naturally arises is from where all these species came, whether they all migrated from other regions or some of them atleast originated in India. Hooker (1906) maintained that India was essentially a meeting place of floras from all directions and it has little original flora. However, some species of *Dipterocarpus, Blepharistemma, Cruddasia* and small groups of Asclepiadaceae are endemic to India. The genus *Utleria* – the only arborescent member of Asclepiadaceae is restricted to India. Besides, *Aegle marmelos, Corchorus capsularis, Piper nigrum, Butea frondosa, Indigofera tinctoria, Datura metal, Calotropis gigantea, Ficus bengalensis, Ficus elastica, Porterisia coarctata, Shorea robusta* are also endemic to India.

It is an established fact that India moved approximately 5000 kms north roughly within 100 million years during Cretaceous and Tertiary periods. Smith and Briden (1977), Smith, Harley and Briden (1981), and Owen (1983) worked on the palaeogeographic maps and depicted the position of India during different geological times. At the advent of the Tertiary

(Palaeocene) according to them, India was in between equator and 15°S. In Early Miocene, even Kanyakumari was at the verge of crossing the line of equator and India was positioned in between the equator and 15°S.

This unusual wandering of India had a drastic effect on plants. Many species could not tolerate the changing climate and perished, some migrated to different countries and others perhaps gave rise to new forms. Kar (1985), Venkatachala *et al.* (1988) dealt with these problems. The antiquity of some of the angiospermic taxa based on palynological observation is discussed below :

Ocimum

The genus *Ocimum* belongs to the family Lamiaceae. According to Mukerjee (1940) it is a small genus and only 9 species are found in the Indian subcontinent. He revised the family Lamiaceae of the Indian subcontinent and opined that the tribe Ocimoideae with the exception of *Lavandula* is confined to the East and Tropical Africa and is more or less absent in other parts of the world. Mukerjee (1940) observed that *Ocimum basilicum* is found in India, Malay Peninsula, China, Formosa and Polynesia. *Ocimum sanctum* is distributed in India, Malay Peninsula, China, Pacific Islands, Australia, Western Asia, Arabia and Japan. *O. americanum* is concentrated in India, China, Japan, Western Asia, Tropical Africa, Madagascar and America (cultivated). *O. kilimandscharicum* originally belongs to Tropical Africa but grows abundantly in the plains of India.

Pollen grains of *Ocimum* and allied genera were studied by Ikuse (1956), Erdtman *et al.* (1961), Embolden (1964), Nair (1965), Henderson *et al.* (1968), Varghese and Verma (1968),Vij and Kashyap (1975), Markgraf and d' Antoni (1978), Bir and Saggoo (1981), Forlani (1981), Saggoo and Bir (1983), Gupta and Sharma (1986), Gupta and Sharma (1990), Kar (unpubl. MS) and others.

Pollen grains of *Ocimum* are mostly subcircular-circular in shape in polar view, hexacolpate, exine 2-4 µm thick, tectate, columellate, some columellae fused at top but free at base, broadly reticulate, pluricolumellate and columella are also present in lumina. (Fig. 2, A-B).

Kar (unpubl. MS) recovered some hexacolpate, subcircular-circular pollen very much resembling the extant pollen of *Ocimum* from a bore hole core drilled by the MECL at Kuchaur-Benia area, in Bikaner District, Rajasthan. These pollen are found in association with *Neocouperipollis kutchensis* (Venkatachala & Kar) Kar & Kumar (1986), *Tricolpites reticulatus* Cookson (1947), *Margocolporites tsukadai* Ramanujam (1966), *Lakiapollis ovatus* Venkatachala & Kar (1969), *Proxapertites operculatus* Van der Hammen (1956), *Proxapertites cursus* van der Hammen (1956), *Calophyllumpollenites rotundus* Sah & Kar (1974), etc. The palynological assemblage advocates an Early Eocene age for the sediments.

Incidentally this happens to be the earliest record of fossil *Ocimum* pollen of the world. Embolden (1964) recorded fossil *Salvia* pollen from the Late Miocene of Alaska, Van Campo (1976) also recovered some Lamiaceous pollen from the Late Miocene of Spain and Menke (1976) reported some from the Pliocene of Germany. This led Kar (unpubl. MS) to postulate that *Ocimum* originated in India. The distributional pattern of different species of *Ocimum* is also centered on India from where the different species might have migrated towards east and west except *O. kilimandscharicum* which seems to be migrated from the tropical Africa.

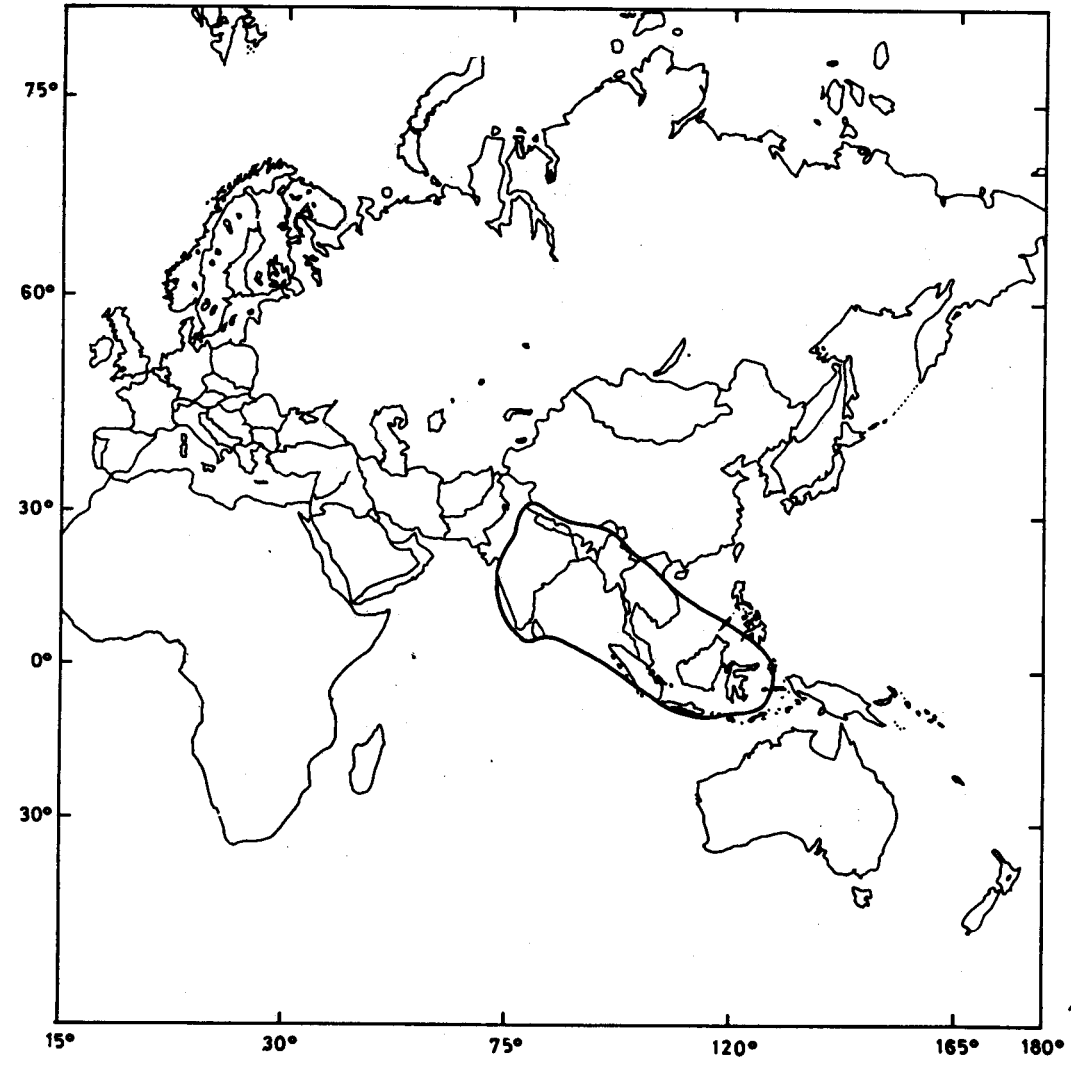

Fig. 1. Present distribution of various species of *Ocimum*.

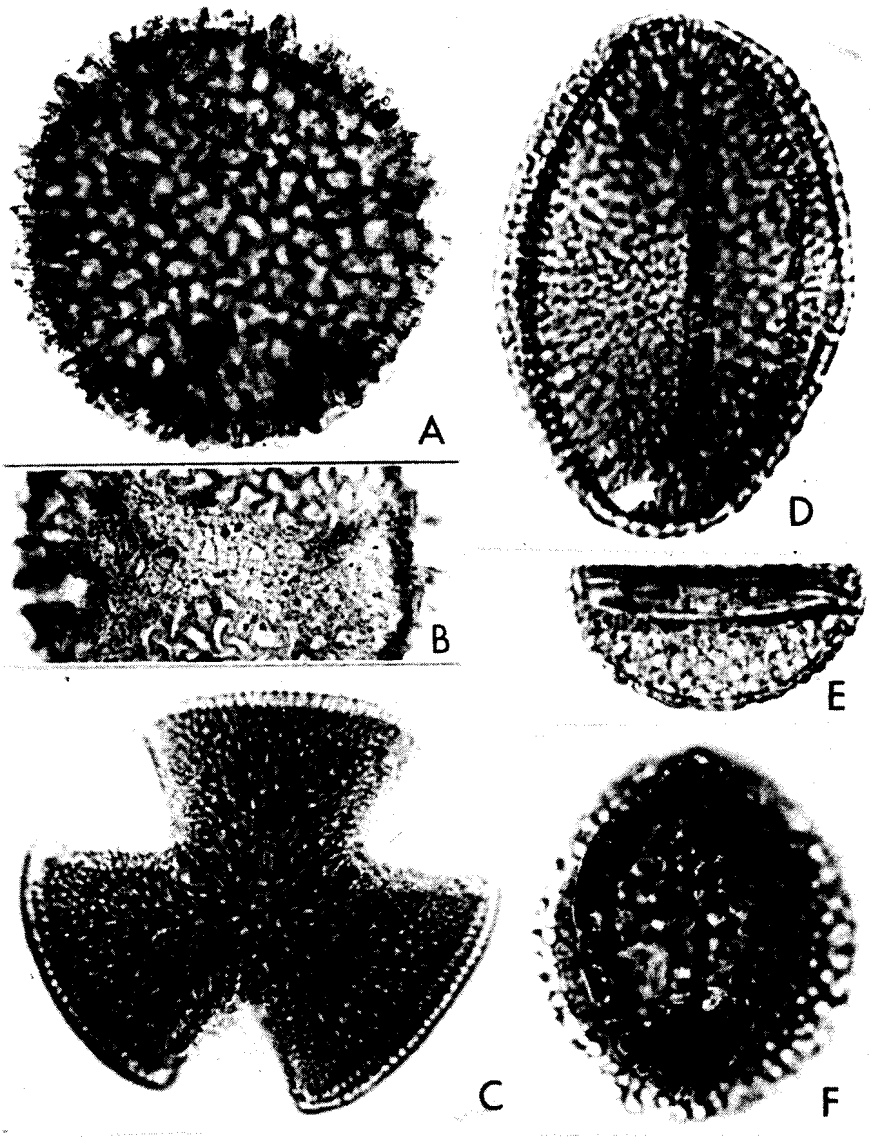

Fig. 2. Fossil pollen grains. A–B. Fossil pollen closely resembling *Ocimum* from the Early Eocene sediments of Rajasthan; B. showing the pluricolumellate reticulation; C–D. Fossil pollen comparable to extant *Dipterocarpus* from the Miocene dsediments of Tamil Nadu; C. polar view; D. equatorial view, E–F. Fossil pollen exhibiting similarity to *Barringtonia* pollen recovered from the Early Eocene rocks of Rajasthan; E. showing areolate reticulation; F. showing pila and aperture.

Kar (unpubl. MS) also commented that the veneration and sanctity that *Ocimum* generates to the mind of people of India is also an additional testimony to the supposition that *Ocimum* grew in India from the very ancient times.

Dipterocarpus

Engler and Prantl (1887-1911) subdivided Dipterocarpaceae into Monotoideae and Dipterocarpoideae. Monotoideae is further subdivided into *Monotes* and *Marquesia.* Both these genera are confined to Africa. Dipterocarpoideae, on the other hand, is divided into Vaterieae, Vaticeae and Shoreae and all the genera of these three subtribes are found mostly in Sri Lanka, India, Burma and Malaysia. Some of the genera of this family, viz., *Dipterocapus, Shorea, Hopea, Doona* and *Vatica* provide valuable timbers. In India, this family grows luxuriantly in Eastern and Western Ghats, at the foothills of the Himalayas and in North East India.

Regarding the origin of Dipterocarpaceae there are two different views. Some authors think that this family originated in Malaysia as many species exhibit luxuriant growth there. Foxworthy (1946) was of the opinion that previously Sumatra, Malay Peninsula and the Philippine Islands were connected with Borneo and in this region Dipterocarpaceae evolved and later migrated to other regions. Kar (1992) remarked that if this contention is true then *Dipterocarpus indicus* Beddome must have travelled through North-Eastern India ultimately to settle in South India as an endemic species during Miocene. Palynological investigation by Dutta and Sah (1970), Nandi (1981), Mathur (1984), Kar (1990-91), Kar *et al.* (1994) of the Tertiary sediments in North-East India failed to recognise any fossil *Dipterocarpus* pollen.

Croizat (1952) postulated that Dipterocarpaceae was evolved in Gondwana countries and migrated from the continental land mass that once occupied the Indian Ocean. According to him this family entered India through Sri Lanka and then migrated to Malaysia.

Pollen grains of *Dipterocarpus* are generally subcircular-circular in polar view, tricolpate or very rarely tricolporoidate. The exine is closely pilate which provides pseudoreticulate appearance in surface view (Fig. 2, C-D). Tissot *et al.* (1994) studied the extant pollen of *Dipterocarpus indicus, D. bourdilloni, Hopea parviflora* and *H. ponga* of Dipterocarpaceae from the wet evergreen forest of Western Ghats in India. Kar (1992) identified fossil *Dipterocarpus* type of pollen from the Miocene sediments of Kerala.

He proposed *Dipterocarpus pollenites* to accommodate this type of pollen and transferred *Tricolpites baculatus* Kar & Jain (1981) and *Retitricolpites dipterocarpodies* Rao & Ramanujam (1982) into it. It may be mentioned here that Awasthi (1974, 1980) described two species of *Dipterocarpoxylon* from Miocene-Pliocene sediments near Pondicherry while Prakash (1975,1978, 1981), Trivedi and Ahuja (1980), Ghosh and Roy (1979) reported same type fossil wood from Miocene sediments of Siwalik and West Bengal respectively.

So it seems that the family Dipterocarpaceae though found in many parts of India and is a dominant constituent of tropical evergreen forest migrated to India only during Miocene (26 million years). It is surprising how within such a relatively short time they populated Western Ghats to northeastern hilly tracts covering approximately a distance of 3000 kms. The chance of migration this family from Malaysia seems to be remote as so far no *Dipterocarpus* type of fossil pollen are recorded from Oligocene and Miocene sediments of north-eastern India.

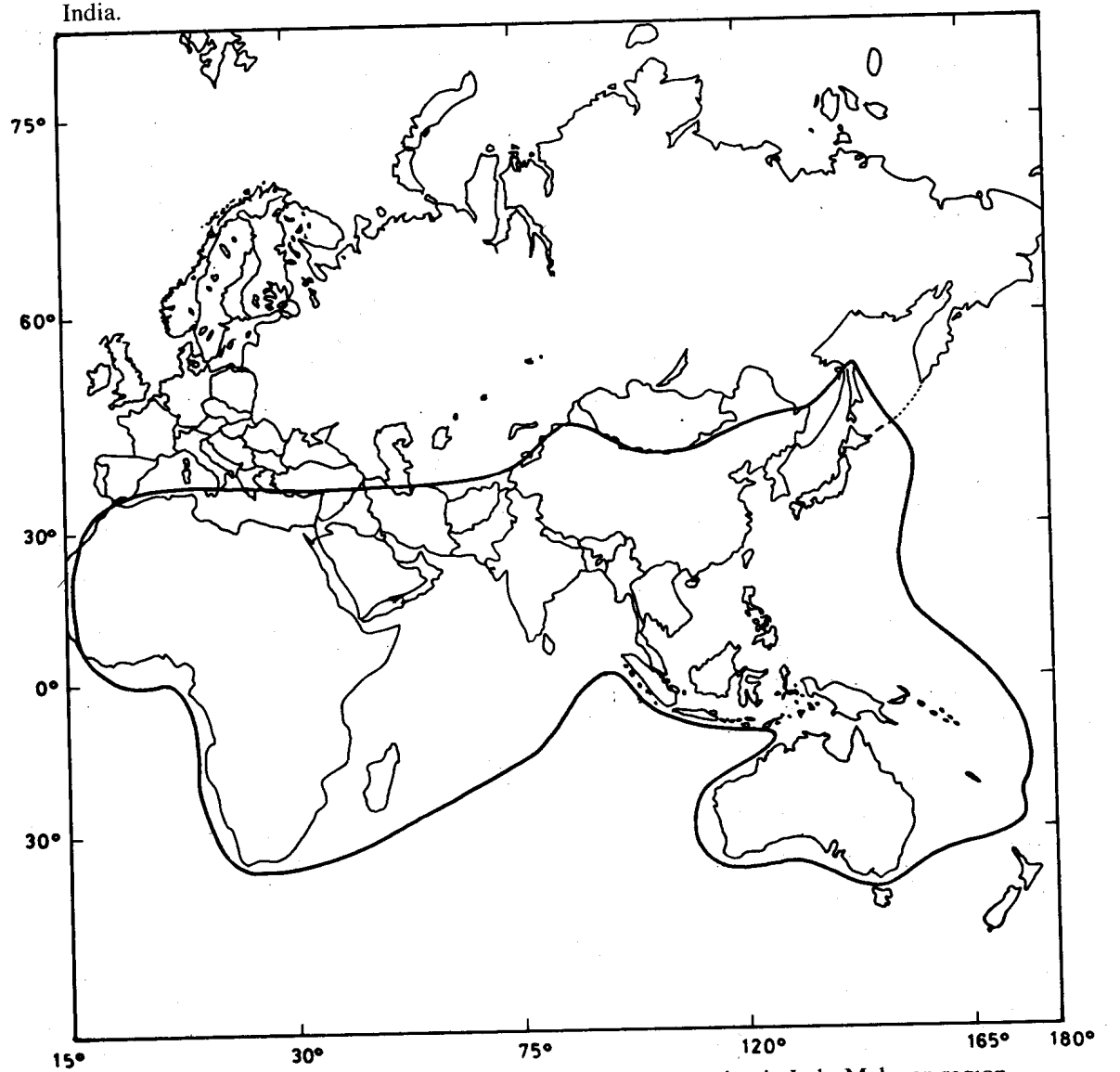

Fig. 3. Distribution of *Dipterocarpus* with its concentration in Indo-Malayan region.

Barringtonia

Barringtonia belongs to the family Lecythidaceae though Croizat (1952) raised this genus to family level. According to him Barringtoniaceae, Bombacaceae, Dipterocarpaceae and Tiliaceae should be regarded as 'near mangroves' because these families inhabiting the tropical, hot lowlands can withstand a long period of drought as well as torrential rains and water logging for a couple of months. Of the family Lecythidaceae, Barringtoniae, Combretodendreae and Foetidieae are commonly found is Asia and Africa including Polynesia and Hawaii while Craterantheae and Napoleoneae are restricted to western Africa.

The dispersed pollen of *Barringtonia* can easily be recognized by its trisyncolpate condition, areolate exine, presence of marginal ridges along the apertures and development of cushions on the polar region.

Muller (1973) traced the apertural evolution in Lecythidaceae. In his opinion basic prototype occurs in Foetidioideae, Napoleonoideae and Lecythidioideae where the pollen grains are only tricolpate and without much elaboration on the exinal pattern. The next evolutionary step is witnessed in *Barringtonia calyptrata* type where the aperture is trisyncolpate. The development of marginal ridges and grooves along the trisyncolpate aperture is attained in *Careya* and *Planchonia* as a next stage of development. The culmination of this trend is seen in *Barringtonia calyptrocalyx* where polar cushion is developed in addition to the above mentioned characters (Fig. 2, E-F).

Fossil pollen very much similar to *Barringtonia* was first reported by Venkatachala and Kar (1968) from the Early Eocene sediments of Kutch. Kar (1979, 1985) also reported this type of pollen from Oligocene and Eocene rocks of the same area. Muller (1981) recorded similar kinds of pollen from Early Eocene of Borneo, while Clarke and Frederiksen (1968) reported them from Late Tertiary rocks of Nigeria.

So it seems that Indo-Malayan region has the earliest fossil record of *Barringtonia* and approximately for the last 55 million years it is still growing in the Indian subcontinent. This genus is rather large but it has many narrow ranging species. *Barringtonia asiatica* is confined only to Andaman Islands, while *B. racemosa* grows in Sri Lanka, South India, Andaman and Nicobar Islands. *B. acutangula* is restricted to Afghanistan, Sri Lanka, India, Bangladesh and Burma. This species is deciduous and at the present time it occurs in India in the Sub Himilayan tract, Assam, West Bengal, Bihar, Orissa, Madhya Pradesh, South India as well as in the western coast.

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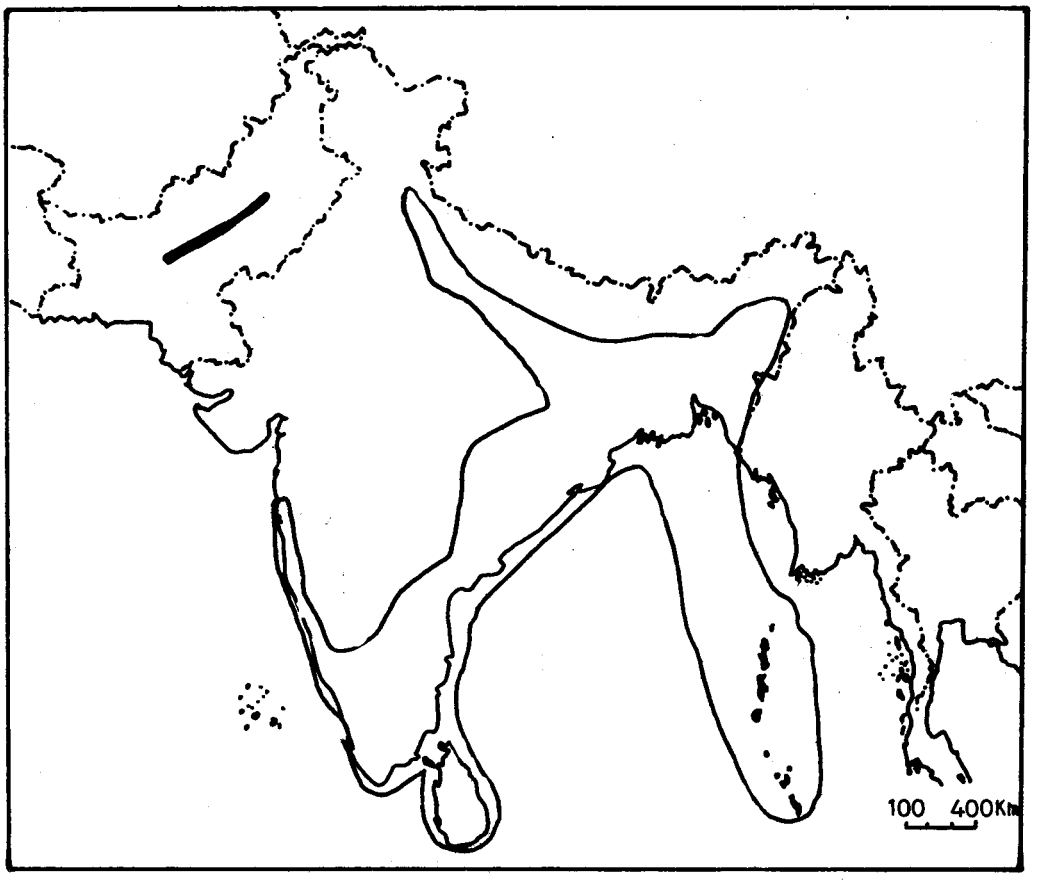

Fig. 4. Distribution of different species of *Barringtonia* in the Indian subcontinent.

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